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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] In a light wave length multiplex transmitter equipped with two or more optical sending circuits which send out the signal light of specific wavelength, respectively, and the optical multiplexing machine which multiplexs two or more signal light One or more optical sending circuits for reserves which can send out the light of said specific wavelength and different wavelength, The light wave length multiplex transmitter characterized by having the supervisory-control circuit which controls said optical sending circuit and the optical sending circuit for reserves, and the electronic switch which changes the main signal of arbitration to the optical sending circuit for reserves with the control signal from said supervisory-control circuit.
[Claim 2] Said electronic switch is the light wave length multiplex transmitter [equipped with the selector which is arranged corresponding to said each optical sending circuit, chooses the one main signal among two or more main signals into which the main signal is received and while being outputted from the tee which branches to two, and said each tee this inputs the main signal with the control signal from a supervisory-control circuit, and is sent out to said optical sending circuit for reserves] according to claim 1.
[Claim 3] The optical transmitting approach characterized by to transmit the line number corresponding to the optical sending circuit which is the optical transmitting approach which carries out wavelength multiplexing of the signal light of two or more wavelength, and is transmitted, and supervised two or more optical sending circuits, made input the main signal corresponding to this optical sending circuit into the optical sending circuit for reserves when it detects that the failure occurred in the optical sending circuit, and made output as a signal light, and a failure generated to an opposite station.
[Claim 4] In a light wave length multiplex receiver equipped with the optical separator which separates wavelength multiple-signal light spectrally, and two or more optical receiving circuits which receive the signal light of specific wavelength, respectively One or more optical receiving circuits for reserves which can receive the light of said specific wavelength and different wavelength, The light wave length multiplex receiver characterized by having the supervisory-control circuit which controls said optical receiving circuit and the optical receiving circuit for reserves, and the electronic switch which takes out the output of the optical receiving circuit for reserves as an output of said optical predetermined receiving circuit with the control signal from said supervisory-control circuit.

[Claim 5] Said electronic switch is the light wave length multiplex transmitter [equipped with the selector which inputs one of the output of the optical receiving circuit which prepares and corresponds the output of said optical receiving circuit for reserves with the tee which branches to two or more outputs corresponding to each optical receiving circuit, and the outputs of said tee, and chooses and outputs one input with the control signal from a supervisory-control circuit] according to claim 4.
[Claim 6] The optical transmitting approach characterized by to make the optical receiving circuit for reserves receive the signal light of the wavelength which is the optical receiving approach of receiving wavelength multiple-signal light, supervised two or more optical receiving circuits, and notified the line number corresponding to the optical receiving circuit which the failure generated to the opposite station when it detected that the failure occurred in the optical receiving circuit, and this optical receiving circuit had received.
[Claim 7] Two or more optical sending circuits which send out the signal light of specific wavelength, respectively, and the optical multiplexing machine which multiplexs two or more signal light, The optical sending circuit for reserves which can send out the light of said specific wavelength and different wavelength, The supervisory-control circuit which controls said optical sending circuit and the optical sending circuit for reserves, The light wave length multiplex transmitter which has the electronic switch which changes the main signal of arbitration to the optical sending circuit for reserves with the control signal from said supervisory-control circuit, The optical separator which separates spectrally two or more signal light by which wavelength multiplexing was carried out, and two or more optical receiving circuits which receive the signal light of specific wavelength, respectively, One or more optical receiving circuits for reserves which can receive the light of said specific wavelength and different wavelength, The wavelength multiplexing optical transmission device characterized by having the supervisory-control circuit which controls said optical receiving circuit and the optical receiving circuit for reserves, and the electronic switch which takes out the output of the optical receiving circuit for reserves as an output of said optical predetermined receiving circuit with the control signal from said supervisory-control circuit.
[Claim 8] When it detects that are the optical transmission approach of transmitting the signal light of two or more wavelength by which wavelength multiplexing was carried out, supervised two or more optical sending circuits, and the failure occurred in the optical sending circuit, If the line number corresponding to the optical sending circuit which was made to input the main signal corresponding to this optical sending circuit into the optical sending circuit for reserves, and was made to output as a signal light, and the failure generated to the opposite station is transmitted and this line number is received in this opposite station The optical transmission approach characterized by changing connection of the optical corresponding receiving circuit 8 to the optical receiving circuit for reserves.
[Claim 9] When it detects that are the optical transmission approach of transmitting the signal light of two or more wavelength by which wavelength multiplexing was carried out, supervised two or more optical receiving circuits, and the failure occurred in the optical receiving circuit, The line number corresponding to the optical receiving circuit which the failure generated to the opposite station is notified, and connection with the output of the optical receiving circuit for reserves of the output of this optical receiving circuit is made. Said opposite station The optical transmission approach which will be characterized by changing the input signal of the optical sending circuit corresponding to the line number to the optical sending circuit for reserves if said line number is received.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to the optical transmission approach using the light wave length multiplex transmitter-receiver and this which have a redundant configuration about a light wave length multiplex transmitter, a light wave length multiplex receiver, and a light wave length asynchronous transfer mode device.
[0002]
[Description of the Prior Art] In light wave length multiplex transmission terminal equipment, super-mass transmission is realized by carrying out multiplex [of the lightwave signal of wavelength with which plurality differs further the optical transmission signal which can hold a mass circuit in per wave using wavelength division multiplexing technology].
[0003] For example, as shown in drawing 5 , in the light wave length multiplex transmission terminal equipment which carries out light wave length multiplex transmission using the lightwave signal of the wavelength of n pieces, it has n the optical sending circuits and the optical receiving circuits corresponding to wavelength of a proper, respectively. In a transmitting side, in the optical multiplexing machine 47, light wave length multiplex [of the signal with which the wavelength of n pieces outputted from n optical sending circuits differs] is carried out, and it is transmitted. In the receiving side, the optical separator 51 distributed the received light wave length multiple signal to n optical receiving circuits, and the lightwave signal of the wavelength of a proper was separated spectrally with light wave length sorting means, such as an optical filter, respectively, and it has received in each optical receiving circuit.
[0004] Since the above, the conventional optical sending circuit, and the optical receiving circuit are huge in the held number of circuit and the effect in disconnection is remarkable, high-reliability has been realized by taking a redundant configuration. That is, each optical sending circuit and an optical receiving circuit are surely equipped with a spare optical sending circuit and a spare optical receiving circuit, respectively. In an optical transmitting side, a selector is arranged for every wavelength and the output of an optical sending circuit and a spare optical sending circuit is chosen. It is multiplexed with an optical multiplexing vessel and the output from each selector is inputted into an optical transmission line. Moreover, in an optical receiving side, the wavelength multiple-signal light in which only the number of wavelength branched with

the optical separator is inputted into the tee prepared corresponding to each optical receiving circuit. This tee branches wavelength multiple-signal light to two outputs, and these two outputs are inputted into an optical receiving circuit and a spare optical receiving circuit.

[0005]

[Problem(s) to be Solved by the Invention] However, in the light wave length asynchronous transfer mode device which takes the conventional redundant configuration, it has the reserve circuit for every optical sending circuit and optical receiving circuit corresponding to each wavelength by which wavelength multiplexing is carried out, respectively. Therefore, in order to perform n waves of light wave length multiplex transmission, 2xn optical sending circuits and optical receiving circuits are needed, respectively, and there is a trouble that the scale of a facility increases remarkably with the increment in wavelength many load resultant pulse numbers.

[0006] The purpose of this invention aims at offering the light wave length asynchronous transfer mode device and the optical transmission approach of lessening the increment in a facility as much as possible, even when making a light wave length asynchronous transfer mode device into a redundant configuration.

[0007]

[Means for Solving the Problem] The light wave length multiplex transmitter of this invention is equipped with two or more optical sending circuits which send out the signal light of specific wavelength, respectively, and the optical-multiplexing machine which multiplexs two or more signal light, and is equipped with one or more optical sending circuits for reserves which can send out the light of said specific wavelength and different wavelength, the supervisory-control circuit which controls said optical sending circuit and the optical sending circuit for reserves, and the electronic switch which changes the main signal of arbitration to the optical sending circuit for reserves with the control signal from said supervisory-control circuit. This electronic switch can be equipped with the selector which is arranged corresponding to said each optical sending circuit, chooses the one main signal among two or more main signals into which the main signal is received and while being outputted from the tee which branches to two, and said each tee this inputs the main signal with the control signal from a supervisory-control circuit, and is sent out to said optical sending circuit for reserves.

[0008] The optical separator with which the light wave length multiplex receiver of this invention separates wavelength multiple-signal light spectrally, One or more optical receiving circuits for reserves which can be equipped with two or more optical receiving circuits which receive the signal light of specific wavelength, respectively, and can receive the light of said specific wavelength and different wavelength, It has the supervisory-control circuit which controls said optical receiving circuit and the optical receiving circuit for reserves, and the electronic switch which takes out the output of the optical receiving circuit for reserves as an output of said optical predetermined receiving circuit with the control signal from said supervisory-control circuit. Moreover, this electronic switch can input one of the output of the optical receiving circuit which prepares and corresponds the output of said optical receiving circuit for reserves with the tee which branches to two or more outputs corresponding to each optical receiving circuit, and the outputs of said tee, and can be equipped with the selector which chooses and outputs one input with the control signal from a supervisory-control circuit. Moreover, the light wave length asynchronous transfer mode device equipped with the above-mentioned light wave length multiplex transmitter and the light wave length multiplex receiver can be constituted. The line number corresponding to the optical sending circuit which the optical transmitting approach of this invention supervised two or more optical sending circuits, it

made input the main signal corresponding to this optical sending circuit into the optical sending circuit for reserves when it detected that the failure occurred in the optical sending circuit, and was made to output it as a signal light, and the failure generated to the opposite station is transmitted. The optical receiving approach of this invention supervises two or more optical receiving circuits, when it detects that the failure occurred in the optical receiving circuit, notifies the line number corresponding to the optical receiving circuit which the failure generated to the opposite station, and makes the optical receiving circuit for reserves receive the signal light of the wavelength which this optical receiving circuit had received.

[0009] When it detects that the optical transmission approach of this invention supervised two or more optical sending circuits, and the failure generated it in the optical sending circuit, The line number corresponding to the optical sending circuit which was made to input the main signal corresponding to this optical sending circuit into the optical sending circuit for reserves, and was made to output as a signal light, and the failure generated to the opposite station is transmitted, and in this opposite station, if this line number is received, connection of the optical corresponding receiving circuit 8 will be changed to the optical receiving circuit for reserves. Moreover, other optical transmission approaches supervise two or more optical receiving circuits, and when it detects that the failure occurred in the optical receiving circuit, the line number corresponding to the optical receiving circuit which the failure generated to the opposite station is notified, connection with the output of the optical receiving circuit for reserves of the output of this optical receiving circuit is made, and said opposite station will change the input signal of the optical sending circuit corresponding to the line number to the optical sending circuit for reserves, if said line number is received.

[0010] The optical transmission approach using the optical transmission device and this which can respond to any failure of wavelength by such configuration only by arranging one reserve circuit by the transmitting side and the receiving side to the wavelength of n pieces, respectively in this invention and by which the configuration was simplified is realizable.

[0011]

[Embodiment of the Invention] Drawing 1 and drawing 2 show the example of the basic configuration of this invention.

[0012] The light wave length multiplex transmitter shown in drawing 1 has the optical sending circuits 1-3 whose optical transmission wave length is n respectively peculiar pieces, one optical sending circuit 4 for reserves of different wavelength from the wavelength of these light sending circuit, electronic switch 6, and optical multiplexing machine 5. An electronic switch 6 has the function which switches a signal to the optical sending circuit for reserves, when a failure occurs in an optical transceiver circuit. The optical multiplexing machine 5 outputs the lightwave signal which these light sending circuit and the optical sending circuit for reserves output to multiplexing and wavelength many weights, and a transmission line. The supervisory-control circuit 11 supervises a failure about the optical sending circuits 1-3, and controls an electronic switch 6. Moreover, while notifying the line number of the signal which the optical sending circuit 4 for reserves has transmitted to an opposite station, the line number from the supervisory-control circuit 12 of an opposite station is received.

[0013] The light wave length multiplex receiver shown in drawing 2 is equipped with an optical separator 6, n optical receiving circuits 7-9 which have the received wavelength of a proper, respectively, the optical receiving circuit 10 for reserves, and the change control circuit 14. An optical separator 6 is equipped with the function which branches the lightwave signal received from the transmission line to n+1 lightwave signal. The supervisory-control circuit 12 supervises

failure generating of the optical receiving circuits 7-9, and controls an electronic switch 14. Moreover, the line number from the supervisory-control circuit 11 of an opposite station is received, and when a failure arises in the optical receiving circuits 7-9, the line number which the failure generated to the opposite station is notified.

[0014] Usually, by control of the supervisory-control circuits 11 and 12, the dummy signal was transmitted at the time of employment, and it has received the optical sending circuit 4 for reserves, and the optical receiving circuit 10 for reserves.

[0015] Suppose that the failure occurred in the optical sending circuit 2 corresponding to the k-th wavelength here. If the failure of the optical sending circuit 2 is detected, the supervisory-control circuit 11 will control an electronic switch 6, and will change the input signal of the k-th optical sending circuit 2 which the failure generated to the input of the optical sending circuit 4 for reserves. At this time, the line number which shows that the signal of the optical sending circuit 2 is transmitted to an opposite station is transmitted. In a receiving side, the supervisory-control circuit's 12 reception of the line number from an opposite station changes connection of the optical receiving circuit 8 of an electronic switch 14 to the optical receiving circuit 10 for reserves. By the above actuation, the signal which was being transmitted in the optical sending circuit 2 and the optical receiving circuit 8 can be changed and transmitted to the optical sending circuit 11 for reserves, and the optical receiving circuit 10 for reserves.

[0016] Next, the case where a failure occurs in the optical receiving circuit 8 corresponding to the k-th wavelength is considered. If the failure of the optical receiving circuit 8 is detected, the supervisory-control circuit 12 will control an electronic switch 14 while it notifies the line number corresponding to the optical receiving circuit 8 which the failure generated to the opposite station to the supervisory-control circuit 11 of a transmitting side, and will change connection of the output of the optical receiving circuit 10 for reserves for the output of the optical receiving circuit 8. If the line number from an opposite station is received, the supervisory-control circuit 11 of a transmitting side will control an electronic switch 6, and will change the input signal of the k-th optical sending circuit 2 corresponding to the line number to the input of the optical sending circuit 4 for reserves. By the above actuation, the signal which was being transmitted in the optical sending circuit 2 and the optical receiving circuit 8 can be changed and transmitted to the optical sending circuit 11 for reserves, and the optical receiving circuit 10 for reserves.

[0017] Electronic switches 6 and 14 can operate as the reserve circuit, even if a failure happens [as opposed to / all / of / from the 1st to the n-th / a circuit] from lambda 1 to which circuit of lambdan, since it can change.

[0018] The detailed example of a configuration of a light wave length multiplex transmitter is shown in drawing 3 .

[0019] The main digital disposal circuits 25-27 are circuits which perform multiplex [of a low-speed signal], and processing of an overhead. The output of each n main digital disposal circuits 25-27 is inputted into n tees 21-23, respectively. In tees 21-23, the inputted main signal is distributed and outputted to two.

[0020] The first output of tees 21-23 is inputted into n optical sending circuits 1-3, respectively. The optical sending circuits 1-3 output the lightwave signal of the optical transmission wave length of lambda 1 - lambdan peculiar to each. Moreover, the supervisory-control circuit 11 has connected and the optical sending circuits 1-3 receive the monitor of a failure, and control.

[0021] The lightwave signal output of n optical sending circuits 1-3 is inputted into the optical multiplexing machine 13. The optical multiplexing machine 13 carries out light wave length

multiplex [of the inputted lightwave signal of the wavelength of n pieces], and outputs it. The optical multiplexing machine with which the optical multiplexing machine 13 has wavelength n or more non-depended input port is used. Moreover, the optical multiplexing machine which has wavelength selection nature called AWG (Arrayed Waveguide Grating) for the purpose which makes small joint loss between the noise rejection from each input port or I/O may be used.

[0022] The second output of tees 21-23 is inputted into a selector 24, respectively. A selector 24 has the change function of n:1, and sorts out and outputs one signal specified by the control signal from n signal inputs. The control signal of a selector 24 is sent from the supervisory-control circuit 11. The signal output of a selector 24 is inputted into the optical sending circuit 4 for reserves. The optical sending circuit 4 for reserves outputs the lightwave signal of wavelength lambdan+1 of a proper which is different in the optical sending circuits 1-3. Usually, dummy light is outputted.

[0023] The lightwave signal output of the optical multiplexing machine 15 and the lightwave signal output of the optical sending circuit 4 for reserves are inputted into the optical multiplexing machine 16. With the optical multiplexing vessel 16, these lightwave signals are outputted to multiplexing and wavelength many weights, and a transmission line. the optical multiplexing machine 15 -- wavelength -- when it has the multiplexing property [**** /-less], the optical multiplexing machines 15 and 16 can be unified and wavelength multiplexing can also be carried out to coincidence.

[0024] The supervisory-control circuit 11 is connected to the optical sending circuits 1-3, the optical sending circuit 4 for reserves, and a selector 24. The supervisory-control circuit 11 performs collection of fault information, and control of an optical output to the optical sending circuits 1-3, and controls an optical output to the optical sending circuit 4 for reserves, and performs the selection control of a signal to a selector 24. The supervisory-control circuit 11 specifies the wavelength which should perform a preliminary change from the inputted fault information, and performs change control of an optical sending circuit. Moreover, in order to synchronize system switching of transmission and reception and to perform it, while the supervisory-control circuit 11 notifies the line number transmitted in the optical sending circuit 4 for reserves to an opposite station, since it corresponds to the change by the failure in the receiving circuit in an opposite station, the notice of the line number from the supervisory-control circuit 12 of an opposite station is received. The notice of such the line number is realized by the approach of superposition of the subcarrier to the overhead lightwave signal of for example, the main signal.

[0025] In an employment condition, the supervisory-control circuit 11 is outputting the change discharge signal to an electronic switch 6, and a communication link is usually performed by the lightwave signal which the failure has not generated in the optical sending circuits 1-3 and which the optical sending circuits 1-3 output. Here, suppose that the failure occurred in the optical sending circuit 2 which transmits the lightwave signal of wavelength lambdak. If the failure of the optical sending circuit 2 is detected in the supervisory-control circuit 11, the supervisory-control circuit 11 will output the control signal which chooses the signal of branching 22 to a selector 24. Moreover, the line number of the circuit which has transmitted to the supervisory-control circuit 12 of an opposite station in the optical sending circuit for reserves is notified. In an opposite station, if change of the line number is detected in the supervisory-control circuit 12, the supervisory-control circuit 12 will output the control signal which chooses the signal of branching 34 to the selector 32 of an electronic switch 14. A redundancy change is completed by the above.

[0026] The optical sending circuit 2 which the failure generated is fixed after a redundancy change, and it usually returns to an employment condition again by returning a redundancy change. Since a change and transmission are possible about all the circuits from lambda 1 to lambdan, the optical sending circuit 4 for reserves operates as a reserve circuit, even if a failure is encountered in any of n optical sending circuits 1-3.
[0027] The detailed example of a configuration of a light wave length multiplex receiver is shown in drawing 4 .
[0028] The light wave length multiple signal inputted from the transmission line is inputted into an optical separator 17. In an optical separator 17, it dichotomizes and the inputted lightwave signal is outputted. The first output of an optical separator 17 is connected to an optical separator 18. An optical separator 18 branches to n pieces, and outputs the inputted wavelength multiplexing lightwave signal from n output ports. An optical separator 18 may use AWG (Arrayed Waveguide Grating), an optical filter, and an optical separator with wavelength selection nature called a fiber grating for the purpose which makes small joint loss between the demand of the wavelength selection nature of each output port, or I/O, although the optical separator which has wavelength n or more non-depended output ports is used. moreover, the optical separator 18 -- wavelength -- when it has the branching property [**** /-less], optical separators 17 and 18 may be unified and you may branch to coincidence.
[0029] The output of n pieces of an optical separator 18 is inputted into the optical receiving circuits 7-9, respectively. The optical receiving circuits 7-9 have optical received wavelength peculiar to each, and receive the lightwave signal of the wavelength of lambda 1 - lambdan. in addition, the case where a wavelength selection system is in an optical separator 18, and the signal of single wavelength is inputted -- the optical receiving circuits 7-9 -- wavelength -- an optical receiving circuit [**** /-less] may be used. Moreover, the fault information of the optical receiving circuits 7-9 is sent out in the supervisory-control circuit 12.
[0030] The second output of an optical separator 17 is connected to the optical receiving circuit 10 for reserves. The optical receiving circuit 10 for reserves is ability ready for receiving about the lightwave signal of wavelength lambdan+1 corresponding to the optical sending circuit 4 for reserves.
[0031] A tee 34 branches and outputs the inputted signal to n pieces. n selectors 31-33 input one in the output of n pieces which a tee 34 outputs as the signal which n optical receiving circuits 7-9 output, respectively, a signal is sorted out and while it was specified by the control signal from the supervisory-control circuit 12 outputs them to the n main digital disposal circuits 35-37, respectively. The main digital disposal circuits 35-37 are circuits which perform separation to a low-speed signal, and processing of an overhead.
[0032] The supervisory-control circuit 12 is connected to the optical receiving circuits 7-9, the optical receiving circuit 10 for reserves, and selectors 31-33. The supervisory-control circuit 12 collects fault information to the optical receiving circuits 7-9, and performs the selection control of a signal to selectors 31-33. The supervisory-control circuit 11 specifies the circuit which should perform a preliminary change from the inputted fault information, and performs change control of an electronic switch 14.
[0033] If actuation is furthermore explained, in an employment condition, the supervisory-control circuit 12 will output the control signal which chooses the signal which the failure has not generated in the optical receiving circuits 7-9, and which the optical receiving circuits 7-9 output to selectors 31-33, and a communication link will usually be performed by the optical receiving circuits 7-9. Here, suppose that the failure occurred in the optical receiving circuit 8

which receives the lightwave signal of wavelength lambdak. If the failure of the optical receiving circuit 8 is detected in the supervisory-control circuit 12, the supervisory-control circuit 12 will output the control signal which chooses the signal of branching 34 to a selector 32. Moreover, the line number of the circuit which has received to the supervisory-control circuit 11 of an opposite station in the optical receiving circuit for reserves is notified. In an opposite station, if change of the line number is detected in the supervisory-control circuit 11, the supervisory-control circuit 11 will output the control signal which chooses the signal of branching 22 to the selector 24 of an electronic switch 6. A redundancy change is completed by the above.

[0034] The optical receiving circuit 8 which the failure generated is fixed after a redundancy change, and it usually returns to an employment condition again by returning a redundancy change. Since the optical receiving circuit 10 for reserves can be changed about all the circuits from lambda 1 to lambdan, even if a failure is encountered in any of n optical receiving circuits 7-9, it operates as a reserve circuit.

[0035] Thus, to the wavelength of n pieces, in a light wave length multiplex transmitter and a light wave length multiplex receiver, it can respond to any failure of wavelength, and a light wave length asynchronous transfer mode device with a configuration simpler than before can be realized only by arranging one wavelength adjustable reserve circuit, respectively. In addition, two or more above-mentioned optical sending circuits for reserves and optical receiving circuits for reserves can also be prepared in a light wave length multiplex transmitter and a light wave length multiplex receiver, respectively.

[0036]

[Effect of the Invention] Since the optical sending circuit and the optical receiving circuit for reserves were established in each of a light wave length multiplex transmitter and a light wave length multiplex receiver in this invention as explained above, the light wave length asynchronous transfer mode device which can respond to any failure of wavelength and consists of a simple light wave length multiplex transmitter of a configuration, a light wave length multiplex receiver, and these is realizable.

[Translation done.]

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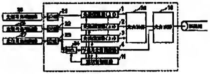
(54) **TRANSMITTER, RECEIVER AND TRANSMITTING DEVICE FOR OPTICAL WAVELENGTH MULTIPLEX, AND OPTICAL TRANSMISSION METHOD**

(57) Abstract:

PROBLEM TO BE SOLVED: To minimize the increase of equipment even in the case of a redundant configuration by providing plural optical transmission circuits, one or more spare optical transmission circuits, a monitoring control circuit which controls the optical transmission circuits and the spare optical transmission circuit and a switching circuit which switches an arbitrary optical transmission circuit to the spare transmission circuit by a control signal from the monitoring control circuit.

SOLUTION: Branching parts 21 to 23 distribute output of a main signal processing circuit into two. Optical transmission circuits 1 to 3 output optical signals of an optical transmission wavelength of λ1 to λn and an optical multiplexer 15 optical wavelength multiplexes the optical signals and outputs them. Here, upon detecting a false of the optical transmission circuit 2, a monitoring control circuit 11 outputs a control signal to a selector 24 so that a signal of the branching part 22 is selected and notifies the monitoring circuit of an opposed station of a circuit number of a circuit which transmits at a spare optical transmission circuit 4. The spare optical transmission circuit 4 can switch/transmit all the circuits from λ1 to λn and operates as a spare circuit for the optical transmission lines 1 to 3.



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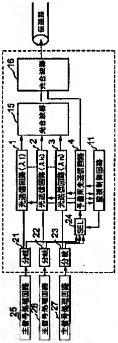
最終頁に続く

(54)【発明の名称】　光波長多重送信器、光波長多重受信器、光波長多重伝送装置、および光伝送方法

(57)【要約】

【課題】冗長構成をとる光波長多重伝送装置では、波長多重される各波長に対応して光送信回路および光受信回路毎にそれぞれ予備回路を備えている。そのため、n波長の光波長多重伝送を行うためにはそれぞれ2×n個の光送信回路と光受信回路が必要となり、設備の規模が著しく増加する。

【解決手段】光波長多重送信器及び光波長多重受信器のそれぞれに予備用の光送信器および光受信器を配置し、障害の発生した光送信回路または光受信回路から上記波長可変の予備回路に切り替える簡易な構成とした。



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【特許請求の範囲】

【請求項1】　それぞれ特定波長の信号光を送出する複数の光送信回路と、複数の信号光を合波する光合波器とを備える光波長多重送信器において、前記特定波長と異なる波長の光を送出することのできる１以上の予備用光送信回路と、前記光送信回路および予備用光送信回路を制御する監視制御回路と、前記監視制御回路からの制御信号によって任意の主信号を予備用光送信回路に切り替える切替回路を備えることを特徴とする光波長多重送信器。

【請求項2】　前記切替回路は、前記各光送信回路に対応して配置され主信号を２つに分岐する分岐部と、前記各分岐部から出力される一方の主信号を受け監視制御回路からの制御信号によって該入力する複数の主信号のうち１つの主信号を選択して前記予備用光送信回路へ送出するセレクタとを備えた請求項１記載の光波長多重送信器。

【請求項3】　複数の波長の信号光を波長多重して送信する光送信方法であって、複数の光送信回路を監視し、光送信回路に障害が発生したことを検知したとき、該光送信回路に対応する主信号を予備用光送信回路に入力させ信号光として出力させ、また対向局に対し障害の発生した光送信回路に対応する回線番号を送信することを特徴とする光送信方法。

【請求項4】　波長多重信号光を分波する光分波器と、それぞれ特定波長の信号光を受信する複数の光受信回路とを備える光波長多重受信器において、前記特定波長と異なる波長の光を受信することのできる１以上の予備用光受信回路と、前記光受信回路および予備用光受信回路を制御する監視制御回路と、前記監視制御回路からの制御信号によって予備用光受信回路の出力を前記所定の光受信回路の出力として取り出す切替回路を備えることを特徴とする光波長多重受信器。

【請求項5】　前記切替回路は、前記予備用光受信回路の出力を複数出力に分岐する分岐部と、各光受信回路に対応して設けられ対応する光受信回路の出力と前記分岐部の出力のうちの１つを入力し監視制御回路からの制御信号によって一方の入力を選択して出力するセレクタとを備えた請求項４記載の光波長多重送信器。

【請求項6】　波長多重信号光を受信する光受信方法であって、複数の光受信回路を監視し、光受信回路に障害が発生したことを検知したとき、対向局に対し障害が発生した光受信回路に対応した回線番号を通知し、該光受信回路が受信していた波長の信号光を予備用光受信回路に受信させることを特徴とする光送信方法。

【請求項7】　それぞれ特定波長の信号光を送出する複数の光送信回路と、複数の信号光を合波する光合波器と、前記特定波長と異なる波長の光を送出することのできる予備用光送信回路と、前記光送信回路および予備用光送信回路を制御する監視制御回路と、前記監視制御回路からの制御信号によって任意の主信号を予備用光送信回路に切り替える切替回路を有する光波長多重送信器と、

波長多重された複数の信号光を分波する光分波器と、それぞれ特定波長の信号光を受信する複数の光受信回路と、前記特定波長と異なる波長の光を受信することのできる１以上の予備用光受信回路と、前記光受信回路および予備用光受信回路を制御する監視制御回路と、前記監視制御回路からの制御信号によって予備用光受信回路の出力を前記所定の光受信回路の出力として取り出す切替回路を備えることを特徴とする波長多重光伝送装置。

【請求項8】　波長多重された複数の波長の信号光を伝送する光伝送方法であって、複数の光送信回路を監視し、光送信回路に障害が発生したことを検知したとき、該光送信回路に対応する主信号を予備用光送信回路に入力させ信号光として出力させ、また対向局に対し障害の発生した光送信回路に対応する回線番号を送信し、該対向局では該回線番号を受信すると、対応する光受信回路８の接続を予備用光受信回路に切り替えることを特徴とする光伝送方法。

【請求項9】　波長多重された複数の波長の信号光を伝送する光伝送方法であって、複数の光受信回路を監視し、光受信回路に障害が発生したことを検知したとき、対向局に対し障害が発生した光受信回路に対応した回線番号を通知し、該光受信回路の出力を予備用光受信回路の出力に接続の切り替えを行い、前記対向局は、前記回線番号を受信すると、回線番号に対応した光送信回路の入力信号を予備用光送信回路に切り替えることを特徴とする光伝送方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、光波長多重送信器、光波長多重受信器、および光波長多重伝送装置に関し、とくに冗長構成を有する光波長多重送受信器とこれを用いた光伝送方法に関する。

【０００２】

【従来の技術】光波長多重伝送端局装置では、１波長当たりに大容量の回線を収容することが可能な光伝送信号を、更に光波長多重技術を用いて複数の異なる波長の光信号を多重することにより超大容量伝送を実現している。

【０００３】例えば図５に示すように、ｎ個の波長の光信号を用いて光波長多重伝送する光波長多重伝送端局装置では、固有の波長に対応した光送信回路および光受信回路をそれぞれｎ個備えている。送信側では、ｎ個の光送信回路から出力されるｎ個の波長の異なる信号が光合波器４７において光波長多重され、送信される。受信側では、受信した光波長多重信号を光分波器５１によってｎ個の光受信回路に分配し、個々の光受信回路で光フィルタ等の光波長選別手段によりそれぞれ固有の波長の光

信号を分波し、受信している。

【０００４】上記、従来の光送信回路および光受信回路は、収容している回線数が膨大であり、回線断における影響が著しいため、冗長構成をとることにより高信頼性を実現している。すなわち、各光送信回路および光受信回路はそれぞれ必ず予備の光送信回路および光受信回路を備えている。光送信側では、各波長毎にセレクタが配置され、光送信回路と予備の光送信回路の出力を選択する。各セレクタからの出力は光合波器で合波され、光伝送路に入力される。また光受信側では、光分波器で波長の数だけ分岐された波長多重信号光は、各光受信回路に対応して設けられた分岐部に入力される。該分岐部は波長多重信号光を２つの出力に分岐し、これら２つの出力は、光受信回路と予備の光受信回路に入力される。

【０００５】

【発明が解決しようとする課題】しかし、従来の冗長構成をとる光波長多重伝送装置では、波長多重される各波長に対応して光送信回路および光受信回路毎にそれぞれ予備回路を備えている。そのため、ｎ波長の光波長多重伝送を行うためにはそれぞれ２×ｎ個の光送信回路と光受信回路が必要となり、波長多重数の増加に伴い設備の規模が著しく増加するという問題点がある。

【０００６】本発明の目的は、光波長多重伝送装置を冗長構成とする場合でも、設備の増加をできる限り少なくすることができる光波長多重伝送装置および光伝送方法を提供することを目的とする。

【０００７】

【課題を解決するための手段】本発明の光波長多重送信器は、それぞれ特定波長の信号光を送出する複数の光送信回路と、複数の信号光を合波する光合波器とを備え、前記特定波長と異なる波長の光を送出することのできる１以上の予備用光送信回路と、前記光送信回路および予備用光送信回路を制御する監視制御回路と、前記監視制御回路からの制御信号によって任意の主信号を予備用光送信回路に切り替える切替回路を備える。この切替回路は、前記各光送信回路に対応して配置され主信号を２つに分岐する分岐部と、前記各分岐部から出力される一方の主信号を受け監視制御回路からの制御信号によって該入力する複数の主信号のうち１つの主信号を選択して前記予備用光送信回路へ送出するセレクタとを備えることができる。

【０００８】本発明の光波長多重受信器は、波長多重信号光を分波する光分波器と、それぞれ特定波長の信号光を受信する複数の光受信回路とを備え、前記特定波長と異なる波長の光を受信することのできる１以上の予備用光受信回路と、前記光受信回路および予備用光受信回路を制御する監視制御回路と、前記監視制御回路からの制御信号によって予備用光受信回路の出力を前記所定の光受信回路の出力として取り出す切替回路を備える。また、この切替回路は、前記予備用光受信回路の出力を複数出力に分岐する分岐部と、各光受信回路に対応して設けられ対応する光受信回路の出力と前記分岐部の出力のうちの１つを入力し監視制御回路からの制御信号によって一方の入力を選択して出力するセレクタとを備えることができる。また上記光波長多重送信器と光波長多重受信器を備えた光波長多重伝送装置を構成できる。本発明の光送信方法は、複数の光送信回路を監視し、光送信回路に障害が発生したことを検知したとき、該光送信回路に対応する主信号を予備用光送信回路に入力させ信号光として出力させ、また対向局に対し障害の発生した光送信回路に対応する回線番号を送信する。本発明の光受信方法は、複数の光受信回路を監視し、光受信回路に障害が発生したことを検知したとき、対向局に対し障害が発生した光受信回路に対応した回線番号を通知し、該光受信回路が受信していた波長の信号光を予備用光受信回路に受信させる。

【０００９】本発明の光伝送方法は、複数の光送信回路を監視し、光送信回路に障害が発生したことを検知したとき、該光送信回路に対応する主信号を予備用光送信回路に入力させ信号光として出力させ、また対向局に対し障害の発生した光送信回路に対応する回線番号を送信し、該対向局では該回線番号を受信すると、対応する光受信回路８の接続を予備用光受信回路に切り替える。また他の光伝送方法は、複数の光受信回路を監視し、光受信回路に障害が発生したことを検知したとき、対向局に対し障害が発生した光受信回路に対応した回線番号を通知し、該光受信回路の出力を予備用光受信回路の出力に接続の切り替えを行い、前記対向局は、前記回線番号を受信すると、回線番号に対応した光送信回路の入力信号を予備用光送信回路に切り替える。

【００１０】このような構成により、本発明ではｎ個の波長に対して、送信側および受信側でそれぞれ１つの予備回路を配置するだけで、いずれの波長の障害にも対応でき、かつ構成の簡略化された光伝送装置とこれを用いた光伝送方法が実現できる。

【００１１】

【発明の実施の形態】図１、図２によって、本発明の基本構成の例を示す。

【００１２】図１に示される光波長多重送信器は、光送信波長がそれぞれ固有なｎ個の光送信回路１～３と、これら光送信回路の波長とは異なる波長の１個の予備用光送信回路４と、切替回路６と、光合波器５を有している。切替回路６は、光送受信回路に障害が発生した時に信号を予備用光送信回路に切り換える機能を有する。光合波器５はこれら光送信回路と予備用光送信回路が出力する光信号を合波・波長多重し、伝送路へ出力する。監視制御回路１１は光送信回路１～３について障害の監視を行い、切替回路６を制御する。また、対向局に対し予備用光送信回路４が送信している信号の回線番号を通知するとともに、対向局の監視制御回路１２からの回線番

号の受信を行う。

【００１３】図２に示される光波長多重受信器は、光分波器６と、それぞれ固有の受信波長を有するｎ個の光受信回路７～９と、予備用光受信回路１０と、切替制御回路１４を備える。光分波器６は伝送路から受信した光信号をｎ＋１個の光信号に分岐する機能を備える。監視制御回路１２は光受信回路７～９の障害発生を監視し、切替回路１４を制御する。また、対向局の監視制御回路１１からの回線番号の受信を行い、光受信回路７～９に障害が生じた場合は対向局に対し障害が発生した回線番号を通知する。

【００１４】通常運用時は、監視制御回路１１、１２の制御により、予備用光送信回路４および予備用光受信回路１０はダミーの信号を伝送し、受信している。

【００１５】ここでｋ番目の波長に対応した光送信回路２に障害が発生したとする。監視制御回路１１は、光送信回路２の障害を検出すると、切替回路６を制御し、障害が発生したｋ番目の光送信回路２の入力信号を予備用光送信回路４の入力に切り替える。この時、対向局に対し光送信回路２の信号を送信していることを示す回線番号を送信する。受信側では監視制御回路１２が対向局からの回線番号を受信すると、切替回路１４の光受信回路８の接続を予備用光受信回路１０に切り替える。以上の動作により、光送信回路２と光受信回路８で伝送していた信号を予備用光送信回路１１と予備用光受信回路１０に切り替えて伝送できる。

【００１６】次に、ｋ番目の波長に対応した光受信回路８に障害が発生した場合を考える。監視制御回路１２は、光受信回路８の障害を検出すると、対向局に対し障害が発生した光受信回路８に対応した回線番号を送信側の監視制御回路１１に通知するとともに切替回路１４を制御し、光受信回路８の出力を予備用光受信回路１０の出力の接続を切り替える。送信側の監視制御回路１１は、対向局からの回線番号を受信すると、切替回路６を制御し、回線番号に対応したｋ番目の光送信回路２の入力信号を予備用光送信回路４の入力に切り替える。以上の動作により、光送信回路２と光受信回路８で伝送していた信号を予備用光送信回路１１と予備用光受信回路１０に切り替えて伝送できる。

【００１７】切替回路６、１４は１番目からｎ番目までの全て回線に対して切替可能であるため、λ１からλｎのいずれの回線に障害が起こってもその予備回路として動作が可能である。

【００１８】図３に光波長多重送信器の詳細な構成例を示す。

【００１９】主信号処理回路２５～２７は低速信号の多重やオーバヘッドの処理を行う回路である。ｎ個の各主信号処理回路２５～２７の出力はそれぞれｎ個の分岐部２１～２３に入力される。分岐部２１～２３では入力された主信号を２つに分配し、出力する。

【００２０】分岐部２１～２３の第一の出力はそれぞれｎ個の光送信回路１～３へ入力される。光送信回路１～３はそれぞれに固有なλ１～λｎの光送信波長の光信号を出力する。また、光送信回路１～３は、監視制御回路１１が接続しており、障害の監視、制御を受ける。

【００２１】ｎ個の光送信回路１～３の光信号出力は光合波器１３に入力される。光合波器１３は、入力されたｎ個の波長の光信号を光波長多重し、出力する。光合波器１３は波長無依存のｎ個以上の入力ポートを有する光合波器が使用される。また各入力ポートからの雑音除去や入出力間の結合損失を小さくする目的でＡＷＧ（Ａｒｒａｙｅｄ Ｗａｖｅｇｕｉｄｅ Ｇｒａｔｉｎｇ）といった波長選択性のある光合波器を使用しても良い。

【００２２】分岐部２１～２３の第二の出力はそれぞれセレクタ２４に入力される。セレクタ２４は、ｎ：１の切り替え機能を有し、ｎ個の信号入力から制御信号により指定された１個の信号を選別し、出力する。セレクタ２４の制御信号は監視制御回路１１から送られる。セレクタ２４の信号出力は予備用光送信回路４へ入力される。予備用光送信回路４は光送信回路１～３とは異なった固有の波長λｎ＋１の光信号を出力する。通常はダミー光を出力している。

【００２３】光合波器１５の光信号出力と予備用光送信回路４の光信号出力は光合波器１６に入力される。光合波器１６ではこれらの光信号を合波・波長多重し、伝送路へ出力する。光合波器１５が波長無依存な合波特性を有している場合は、光合波器１５、１６を一体化し、同時に波長多重することもできる。

【００２４】監視制御回路１１は、光送信回路１～３、予備用光送信回路４、セレクタ２４に接続する。監視制御回路１１は、光送信回路１～３に対しては障害情報の収集および光出力の制御を行い、予備用光送信回路４に対しては光出力の制御を行い、またセレクタ２４に対しては信号の選択制御を行う。監視制御回路１１は入力された障害情報から予備切り替えを行うべき波長を特定し、光送信回路の切り替え制御を行う。また、送受信の回線切替を同期させて行うため、監視制御回路１１は予備用光送信回路４で送信している回線番号を対向局へ通知するとともに、対向局での受信回路での障害による切替に対応するため対向局の監視制御回路１２からの回線番号通知を受信する。このような回線番号の通知は、例えば主信号のオーバヘッド光信号へのサブキャリアの重畳といった方法で実現される。

【００２５】光送信回路１～３に障害が発生していない通常運用状態においては、監視制御回路１１は切替回路６に対して切替解除信号を出力しており、通信は光送信回路１～３の出力する光信号によって行われる。ここで、波長λｋの光信号を送信する光送信回路２に障害が発生したとする。光送信回路２の障害が監視制御回路１１で検出されると、監視制御回路１１はセレクタ２４に

対し分岐２２の信号を選択する制御信号を出力する。また、対向局の監視制御回路１２に対し予備用光送信回路で送信している回線の回線番号を通知する。対向局では回線番号の変化が監視制御回路１２で検出されると、監視制御回路１２は切替回路１４のセレクタ３２に対し分岐３４の信号を選択する制御信号を出力する。以上により、冗長切り替えが完了する。

【００２６】冗長切り替え後、障害の発生した光送信回路２の修理を行い、冗長切り替えを切り戻すことにより再び通常運用状態に復帰する。予備用光送信回路４はλ１からλｎまでの全ての回線について切替・送信が可能であるため、ｎ個の光送信回路１～３のいずれに障害が起こっても予備回路として動作する。

【００２７】図４に光波長多重受信器の詳細な構成例を示す。

【００２８】伝送路から入力された光波長多重信号は光分波器１７へ入力される。光分波器１７では入力された光信号を２分岐し、出力する。光分波器１７の第一の出力は光分波器１８に接続される。光分波器１８は入力された波長多重光信号をｎ個に分岐し、ｎ個の出力ポートから出力する。光分波器１８は波長無依存のｎ個以上の出力ポートを有する光分波器が使用されるが、各出力ポートの波長選択性の要求や入出力間の結合損失を小さくする目的でAWG（Ａｒｒａｙｅｄ　Ｗａｖｅｇｕｉｄｅ　Ｇｒａｔｉｎｇ）や光フィルタ、ファイバグレーティングといった波長選択性のある光分波器を使用しても良い。また、光分波器１８が波長無依存な分岐特性を有している場合は、光分波器１７、１８を一体化し、同時に分岐してもよい。

【００２９】光分波器１８のｎ個の出力はそれぞれ光受信回路７～９へ入力される。光受信回路７～９はそれぞれに固有な光受信波長を有しており、λ１～λｎの波長の光信号を受信する。なお、光分波器１８に波長選択制があり、単一波長の信号が入力される場合は光受信回路７～９は波長無依存な光受信回路を用いても良い。また、光受信回路７～９の障害情報は監視制御回路１２へ送出される。

【００３０】光分波器１７の第二の出力は予備用光受信回路１０に接続される。予備用光受信回路１０は予備用光送信回路４に対応した波長λｎ＋１の光信号を受信可能である。

【００３１】分岐部３４は入力された信号をｎ個に分岐し、出力する。ｎ個のセレクタ３１～３３は、それぞれｎ個の光受信回路７～９の出力する信号と、分岐部３４が出力するｎ個の出力の中の１個を入力し、監視制御回路１２からの制御信号により指定された一方の信号を選別し、それぞれｎ個の主信号処理回路３５～３７に出力する。主信号処理回路３５～３７は低速信号への分離やオーバヘッドの処理を行う回路である。

【００３２】監視制御回路１２は、光受信回路７～９、予備用光受信回路１０、セレクタ３１～３３に接続する。監視制御回路１２は、光受信回路７～９に対しては障害情報の収集を行い、セレクタ３１～３３に対しては信号の選択制御を行う。監視制御回路１１は入力された障害情報から予備切り替えを行うべき回線を特定し、切替回路１４の切り替え制御を行う。

【００３３】さらに動作について説明すると、光受信回路７～９に障害が発生していない通常運用状態においては、監視制御回路１２はセレクタ３１～３３に対して光受信回路７～９の出力する信号を選択する制御信号を出力しており、通信は光受信回路７～９によって行われる。ここで、波長λｋの光信号を受信する光受信回路８に障害が発生したとする。光受信回路８の障害が監視制御回路１２で検出されると、監視制御回路１２はセレクタ３２に対し分岐３４の信号を選択する制御信号を出力しする。また、対向局の監視制御回路１１に対し予備用光受信回路で受信している回線の回線番号を通知する。対向局では回線番号の変化が監視制御回路１１で検出されると、監視制御回路１１は切替回路６のセレクタ２４に対し分岐２２の信号を選択する制御信号を出力する。以上により、冗長切り替えが完了する。

【００３４】冗長切り替え後、障害の発生した光受信回路８の修理を行い、冗長切り替えを切り戻すことにより再び通常運用状態に復帰する。予備用光受信回路１０はλ１からλｎまでの全ての回線について切替可能であるため、ｎ個の光受信回路７～９のいずれに障害が起こっても予備回路として動作する。

【００３５】このように、ｎ個の波長に対して、光波長多重送信器および光波長多重受信器において、それぞれ１つの波長可変の予備回路を配置するだけで、いずれの波長の障害にも対応でき、かつ従来より構成が簡易な光波長多重伝送装置が実現できる。なお、上述の予備用光送信回路および予備用光受信回路は、光波長多重送信器および光波長多重受信器においてそれぞれ複数設けることもできる。

【００３６】

【発明の効果】以上説明したように、本発明においては、光波長多重送信器および光波長多重受信器のそれぞれに予備用の光送信回路および光受信回路を設けたので、いずれの波長の障害にも対応でき、かつ簡易な構成の光波長多重送信器、光波長多重受信器、およびこれらから構成される光波長多重伝送装置が実現できる。

【図面の簡単な説明】

【図１】本発明の光波長多重送信器の基本構成図。

【図２】本発明の光波長多重受信器の基本構成図。

【図３】本発明の光波長多重送信器の構成例を示すブロック図。

【図４】本発明の光波長多重受信器の構成例を示すブロック図。

【図５】従来の光波長多重伝送装置のブロック図。

【符号の説明】

１、２、３　光送信回路

４　予備用光送信回路

５、１５、１６、４７　光合波器

６、１７、１８、５１　光分波器

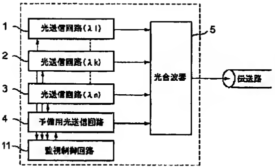
７、８、９　光受信回路

１０　予備用光受信回路

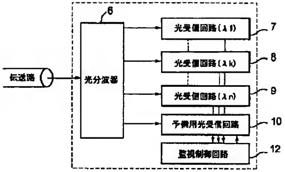
１１、１２　監視制御回路

２１、２２、２３、３４　分岐部

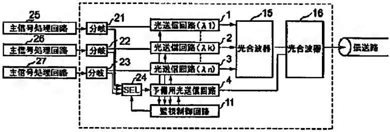
【図１】



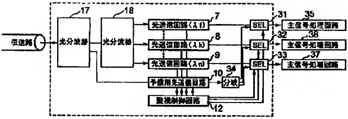
【図２】



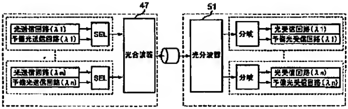
【図３】



【図４】



【図５】



フロントページの続き

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